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Environment, Safety, and Health

Volume II

Part 12: General H&S Controls-Safety Equipment and Facilities

Document 12.2
Ventilation

Recommended for approval by the ES&H Working Group

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New document or new requirements

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Ventilation*

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* **Editorial revision**

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Ventilation

1.0 Introduction

Effectively controlling exposures to airborne hazards, including toxic substances, radionuclides, and biological hazards, is essential to maintaining safe working conditions at LLNL. The importance of engineering controls to prevent exposures to airborne hazards is stated in Section 2.3 of Document 2.2, "Managing ES&H for LLNL Work," in the *ES&H Manual.* Ventilation is the most important engineering control used to prevent exposures to airborne hazards.

This document provides information about designing new ventilation systems and substantial modifications to existing systems to assure the installed equipment works successfully and complies with applicable codes of good practice. It also provides a framework for responding to indoor air quality situations.

This document and its associated documents affect four groups:

- The group that is having a ventilation system installed or modified.
- The group designing the ventilation system.
- The ES&H Team, representing the Environmental Protection and Hazards Control Departments.
- The group that installs or modifies the ventilation system.

The first three groups must work closely together from the earliest stages of a project. This means that the three must agree on the basic design and layout of the system before the equipment and materials are selected and before resources of space, personnel, and funds are allocated. This will reduce the likelihood that problems will emerge during work planning, installation, and operation of the project and will allow cost-effective solutions to be developed. This will also assure that the designers know what the users need and what the ES&H constraints are before equipment is designed, installed, and operated.

2.0 Applicability

This document addresses the design, use, and maintenance of ventilation systems used to control air contamination in workplaces and the inspection and maintenance of heating, ventilation, and air conditioning (HVAC) systems to avoid and respond to indoor air quality concerns. Contaminant control ventilation systems are those used to

control health and environmental hazards and include, but are not limited to, the following:

- Laboratory hoods.
- Glove boxes.
- Flexible or lateral exhaust hoods in welding areas.
- Slot hoods behind open surface tanks or silk screening benches.
- Gas storage cabinets.
- Paint spray booths.

All new ventilation installations and modifications to existing systems shall meet the requirements of the Work Smart Standards listed in Section 10.0 and the references listed in Section 11.0 of this document as well as the requirements of Document 31.1, "Air Quality Compliance," in the *ES&H Manual*. (Copies of these documents are available from the area ES&H Teams.) Existing ventilation systems shall meet the requirements in effect at the time of installation and do not have to be upgraded except to meet OSHA and other regulatory requirements or if experience demonstrates that an upgrade is needed. For guidance, construction criteria, and inspections, contact your area ES&H Team.

3.0 General Design and Planning Considerations

Designers, applicable Hazards Control Department and Environmental Protection Department disciplines, and clients shall coordinate with each other to identify and resolve concerns that will prevent the installation or use of an effective and economical system during the planning stages for installing new ventilation systems or modifying existing systems before resource allocation and formal plan review occurs. The formal documentation specified in Document 2.2 complements this coordination, but can never replace it.

Plans for ventilation systems for the control of hazardous airborne contaminants shall be either designed or reviewed by a mechanical engineer with specific training and experience on the design of industrial contaminant control ventilation systems as well as familiarity with environmental protection regulations concerning air emissions and the liquid emissions from scrubbers. Plans for general ventilation systems shall be either prepared or reviewed by a mechanical engineer with HVAC training and experience. Ventilation system designs shall consider ease of use. Inconvenience could be created by, for example, requiring the user to go through a great deal of effort to position or set up a ventilation system, making the controls hard to use or understand, or by locating controls or the readouts of monitoring devices in remote locations.

There may also be conflicting requirements present from one standard to another. Significant known conflicts, such as differing requirements or guidance concerning lab hoods and glove boxes are addressed in this document and/or the associated documents. Other conflicts shall be evaluated and resolved by the area ES&H Team on a case-by-case basis and documented in writing. The ES&H Team shall contact the subject matter expert, if necessary.

Airflow shall proceed from areas with relatively little contamination toward areas that are locations of air contaminant sources. In offices, this is generally done by moving air from desk areas to reprographic spaces or bathroom exhausts. In labs, this is done by moving air from office spaces into labs where it is removed by hoods. The building can be divided into zones of progressively greater negative pressure to ensure proper air motion to control radionuclides, highly toxic chemicals, or biohazards. In shop buildings, this is done by moving air from offices and light workbench areas towards places where chemicals are used, such as darkrooms, welding areas, paint spray booths, or open surface tanks.

4.0 Prestart Reviews

Proper installation requires close cooperation between the design group, the LLNL group overseeing the installation of the system, and the ES&H Team. The group primarily responsible for the HVAC or contaminant control ventilation system being installed or modified shall ensure that the system is acceptance tested, that permit-related tests are conducted, and that any necessary prestart reviews are conducted before the ventilation system is put into use. A balance testing consultant usually does HVAC acceptance testing and reports results to Plant Engineering. The Hazards Control Department conducts acceptance tests of all contaminant control ventilation systems and sends test results to facility management.

5.0 System Maintenance and Inspection

The group primarily responsible for the ventilation system shall ensure that it is maintained to minimize or eliminate standing or stagnant water and leaks of water or air to forestall the development of odor and indoor air quality issues. Ventilation systems shall also be maintained to eliminate air leaks. Problems found during maintenance shall be corrected within a reasonable time. Inspections and maintenance of HVAC systems shall be documented in writing, including the name of the individual(s) inspecting and/or maintaining the system, the date of the inspection and/or maintenance, and the specific findings and actions taken.

The group primarily responsible for the ventilation system shall ensure that contaminant control ventilation systems are tested at least annually by the Hazards Control Department after initial acceptance testing. Additional tests can be conducted as requested by the programs, as required to comply with regulations, in response to emergencies, or when there is reason to believe that the performance of a ventilation system is deteriorating. Plant Engineering usually tests HVAC systems on request after the HVAC system is accepted and put into use. Ventilation tests of HVAC systems conducted in response to indoor air quality concerns are done by the Hazards Control Department using design criteria and previous test result data supplied by Plant Engineering to determine if ventilation still meets design objectives. Many indoor air quality concerns result from deteriorating HVAC system performance.

6.0 Locations of Exhaust Ventilation System Air Movers

Fans/air movers shall be located outdoors or in penthouses reserved for fans and air cleaners so leaking ductwork will not contaminate "clean" areas. Air cleaners shall be located upstream of air movers to protect the air movers from contamination unless there is sound engineering reason to do otherwise and should be located in penthouses.

7.0 Exhaust Ventilation Systems

7.1 General Considerations for Contaminant Control Ventilation Systems

Local exhaust systems are designed to remove contaminants before they reach the breathing zones of people. They are the best control for emissions from point sources. Exhaust systems should be combined with source enclosure to allow maximum control with minimum airflow.

In general, a room ventilation system, which provides 4-12 air changes per hour, should be adequate for laboratories, which utilize local exhaust systems as the primary method for controlling air contaminants. Four air changes per hour shall be the minimum for laboratory areas. More airflow may be required based on the specific circumstances and operations of the laboratory.

See Document 12.3, "Evaluation and Control of Facility Airborne Effluents," in the *ES&H Manual* for information about ventilation for specific laboratory and industrial situations.

7.2 Environmental Permitting Considerations

Air pollution's impact on public health, the environment, and the economy is substantial and has resulted in regulation through federal, state, and local government agencies. Laws and regulations governing air quality can be divided into two groups: those that deal with pollutants generated mostly by combustion ("criteria pollutants"), and those that deal with compounds known as toxic air contaminants (a California term for air toxics—also called hazardous air pollutants [HAPs] under federal law). Toxic air contaminants have the potential to cause increased likelihood for cancer or reproductive toxicity as well as acute or chronic health effects. In California, sources of air pollution are largely regulated through a permit system and the application of prohibitory rules. This permit system is designed to permit each piece or group of equipment or process that may emit air pollutants on an individual basis. Permits may be required for (1) new equipment or operations that may cause air pollution and (2) modifications to equipment, throughputs, processes or materials.

The air permitting process is driven, in part, by the federal Clean Air Act (CAA). The purpose of the CAA is to protect the public health of the most sensitive portion of the population, such as children, frail elderly, and those with allergies, asthma, or emphysema. To accomplish this, regulation of air pollution involves federal, state, and local agencies. On the federal level, the EPA is responsible for promulgating nationwide standards and oversight of air quality planning and regulatory implementation conducted by the state and local air districts. The State of California Air Resources Board (ARB) is responsible for adopting state ambient air quality standards, and regulating vehicular sources of air pollution on the state level. At the local level, the air districts are responsible for stationary sources, region-wide planning, and permitting. Most often, the agencies pursuing enforcement actions against facilities not in compliance will be the local air districts.

7.3 Replacement Air

Replacement, or "makeup" air, shall be supplied to replace air that is removed by exhaust systems. Replacement air shall be introduced to enhance contaminant control and occupant comfort. Designs for new installations or modifications to existing installations shall assure that allowance is made for adequate makeup air to enter the space at low velocity. This avoids creating jets of air that will overwhelm the ventilation provided by a local exhaust ventilation system. Generally, it is specified that the velocity of air from a makeup air opening, or any other source, is below 50 fpm when it passes by a hood opening. Admitting the air through a broad plenum, in which the air velocity is reduced and flow is distributed evenly, before the air is injected into an area can do this. Ventilation systems shall also be located to avoid situations where makeup air must make sharp turns to enter the hood or where turbulence from pedestrian/vehicle traffic or jets of air from HVAC systems can defeat the ventilation system.

7.4 Recirculation of Contaminated Air

With the concurrence of the ES&H Team, recirculation of air (used in ventilated areas in which there is the potential for toxic, carcinogenic, or radioactive materials) may be permitted for systems handling small quantities of contaminants where the use of the system was not likely to change.

7.5 Separation of Building Exhausts and Ventilation Air Intakes

The intake for the replacement air system shall be located to prevent reentry of contaminants from its own exhaust systems or other sources (see Chapter 14 of the *ASHRAE Handbook, Fundamentals*[1] and Document 12.3).

7.6 Air Cleaning Devices

Air-cleaning devices are used to reduce contaminants from effluents to allowable limits before being discharged to the environment. The performance requirements of air cleaners shall be set by the ES&H Teams based on Work Smart Standards. For additional information on air-cleaning devices, see the references in Section 11.0 and Document 12.5, "High-Efficiency Particulate Air (HEPA) Filter system Design Guidelines for LLNL Applications," in the *ES&H Manual*.

The levels of contaminants released through stacks shall be kept as low as practical and in compliance with regulatory requirements. Methods for evaluating operational discharges, stack dilution, and environmental dispersion are presented in Document 12.3. Air monitoring for toxic or radioactive materials and/or redundant air cleaning equipment may be required. Contact your ES&H Team for information and requirements concerning air cleaners.

8.0 Office Ventilation Systems

Dilution (general) ventilation is used to control common office contaminants being released or maintain worker comfort in large areas. This method is not normally suitable for the control of airborne contaminants except when the contaminants are only slightly toxic, the rate of generation is small and essentially constant, personnel work at a sufficient distance from the point of release, and the air is well mixed. This is why dilution ventilation is not used in laboratories or shops but is used in offices.

HVAC systems shall be designed, maintained, and operated to provide at least the quantity of outdoor air, based on actual occupancy, required by the enforceable building code in effect at the time the design of the building/modification project was completed and should be designed to meet the specifications of American Society of

Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), Standard 62-1989[2], whichever is more stringent. ASHRAE Standard 62-1989 includes a ventilation rate procedure and an indoor air quality assessment procedure for achieving an acceptable indoor environment. ASHRAE 62-1989 also has air concentration limits for some air contaminants set to avoid creating significant nuisances.

The HVAC system shall be operated continuously, which means the thermostat shall be set to allow the fan to operate on demand or the fans shall be running at all times, during working hours except:

- During scheduled maintenance and emergency repairs.
- When it can be demonstrated by a record of measurements and calculations that the required outdoor air supply rate is satisfied by infiltration and/or a non-mechanical outdoor air supply system. HVAC energy conservation systems with activation timers should be set to activate the HVAC system at least one hour prior to occupancy in order to ensure good air quality at the beginning of the work day.

When used in a new location with several zones, general ventilation shall start with the cleanest location and be exhausted at the most contaminated to avoid moving contamination into clean areas. Changes to floor layout of existing facilities shall consider ventilation; moving workers to previously unoccupied and poorly vented areas is a common cause of indoor air quality difficulties.

Facility management shall refer indoor air quality issues that *do not involve health impacts* to the Air Conditioning Shop using a Whiz Tag. The Air Conditioning Shop determines if the Hazards Control Department support is needed and the area ES&H Team provides that support. An Indoor Air Quality Action Team consisting of the appropriate facility management, area industrial hygienist, and a representative from the Air Conditioning Shop answers specific issues. The facility management shall call the ES&H Team serving the building if *there are health impacts*, such as complaints of symptoms or if workers are referred to the Health Services Department. The Hazards Control Department and the Air Conditioning Shop will work together to resolve issues, as needed.

Due to nature of their assignment, janitorial personnel are apt to be among the first to notice evidence of water damage, a major cause of indoor air quality problems because the moisture sustains the growth of microorganisms, and odors. Janitorial personnel are encouraged to request a review of conditions by the facility management when such evidence is observed. The Air Conditioning Shop also inspects building/trailer air conditioning systems upon request and makes repairs or replaces parts as needed.

An Indoor Air Quality Action Team with, at minimum, members from the Plant Engineering Air Conditioning Shop, the Hazards Control Department industrial hygiene discipline, and the facility management shall coordinate the handling of indoor air quality issues.

9.0 Responsibilities

Achieving the above objectives requires the coordination of various departments, groups, and individuals. All workers and organizations shall refer to Document 2.1, "Laboratory and ES&H Policies, General Worker Responsibilities, and Integrated Safety Management," in the *ES&H Manual* for a list of general responsibilities. This section describes specific responsibilities of LLNL organizations and workers who have key safety roles.

9.1 Clients/Users (Facilities and Programs)

Generally, facility management is responsible for building equipment and programs are responsible for program equipment in or out of buildings. Authorizing Organizations:

- Coordinate planning of new systems and modifications of existing systems with the Plant Engineering/design groups and appropriate members of the ES&H field teams early in the design phase before resources are committed.
- Ensure design groups other than Plant Engineering are advised of the requirements of this document and all applicable associated documents before design work begins.
- Ensure design groups other than Plant Engineering carry out the planning and coordination tasks listed in Section 3.0.
- Ensure that sufficient time is allocated for proper design and review of designs by the area ES&H Team.
- Provide sufficient funds to ensure systems comply with codes/standards and prevent the development of hazards/significant nuisances.
- Ensure that appropriate environmental permits are obtained in coordination with the Environmental Protection Department.
- Ensure that the requirements of the safety analysis process described in Document 3.1, "Safety Analysis Program," in the *ES&H Manual* are fulfilled.
- Ensure that newly installed and modified HVAC or contaminant control ventilation systems are acceptance tested, plans are made to resolve issues identified in acceptance testing, and the plans are executed in a timely

manner following a graded approach in which the most serious/important issues are resolved first.

- Ensure that HVAC and contaminant control ventilation systems are maintained.
- Report air quality and ventilation problems to the area ES&H team.
- Monitor the performance of ventilation/air cleaning systems each time a system is used and by periodically checking the indication of performance monitors, such as manometers or Magnahelic gauges.
- Suspend all operations served by a contaminant control ventilation system that has failed or no longer meets performance or design specifications (unless other emergency procedures are approved) and
  - Notify the Hazards Control Department if a ventilation system used for control of radioactive, carcinogenic, or toxic material fails or there is reason to believe that it could no longer be operating in accordance with performance or design specifications, and
  - Request guidance in mitigating any hazardous situation and in determining the most effective means of restoring the system.
- Ensure that a record of ductwork contamination is maintained, with the assistance of the ES&H Team, to guide system maintenance and decommissioning and demolition.
- Contact the Air Conditioning Shop and turn in a Whiz Tag for ventilation system inspections or troubleshooting when deterioration of ventilation performance is suspected or if equipment and personnel movements result in locating people in poorly ventilated spaces. The Air Conditioning Shop may subsequently call the area ES&H Team if industrial hygiene support is needed.
- Contact the ES&H Team when indoor air quality or other ventilation issues have health impacts. The ES&H Team may subsequently call the Air Conditioning Shop if mechanical equipment support is needed.
- Coordinate with Janitorial staff to ensure they communicate to the Facility Point of Contact any evidence of water damage or other evidence of ventilation problems.

9.2 ES&H Teams

- Support the planning of new systems and modifications to existing systems with Plant Engineering/design groups and clients.

- Help responsible groups determine if new operations or modifications and ventilation systems require modifying safety analysis documentation.
- Formally review plans for new installations or modifications to existing installations.
- Provide information about operating requirements of ventilation systems and air cleaning systems.
- Resolve any conflicts between various standards/good practices.
- Check new installations or modifications of ventilation systems installed to control health and environmental hazards for compliance with performance specifications and regulatory requirements.
- Respond to indoor air quality complaints in coordination with the Air Conditioning Shop and participate in investigations of indoor air quality concerns.

9.3 Hazards Control Department

Safety Analysis Staff

- At the request of the responsible groups, prepares safety analysis documentation as needed using inputs from the ES&H Teams and responsible groups.

Safety Programs Division

- Provide current information about standards and good practice for ventilation system design to the ES&H Teams.
- Help ES&H Teams resolve conflicts between standards, upon request.

9.4 Plant Engineering/Design Group Retained by Programs

- Ensure that engineers assigned to design plans for contaminant control ventilation systems are adequately trained to design these systems, or that they are supervised by an engineer who has received such training.
- Route plans through the ES&H Teams for review *before* contracts are let.
- Ensure that systems are designed in accordance with mandatory requirements and provisions of good practice specified by the references to this document and its associated documents.

- Ensures that newly installed systems are performance tested after the balancing phase before the Hazards Control Department conducts performance tests.

9.5 Plant Engineering Shops

- Maintain awareness of general conditions in buildings, especially the existence of standing water and malodors.
- At facility management request, conduct visual inspections of the fan systems during routine periodic mechanical inspections to ensure accumulations of standing water or leaking water do not support the growth of microorganisms.
- At facility management request, maintain ventilation systems to minimize or eliminate standing or stagnant water and leaks of water.
- Work with facility points of contact to correct problems found during inspections.
- Document inspections and maintenance of HVAC systems.

9.6 Environmental Protection Department

The Operations and Regulatory Affairs Division of the Environmental Protection Department will provide information and requirements concerning the following:

- Regulatory requirements.
- National Emission Standards for Hazardous Air Pollutants (NESHAPs) requirements.
- Environmental ALARA program.
- Permitting and exemption requests.
- Pollution prevention.
- Waste minimization.
- Effluent treatment.
- National Environmental Protection Act/California Environmental Quality Act (NEPA/CEQA) documentation.

10.0 Work Smart Standards

22 CCR Division 4.5 Chapter 14 (66264.1030, 1050, 1080 et seq.), "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities"

22 CCR Division 4.5 Chapter 15 (66265.1030, 1050, 1080 et seq.), "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities"

10 CFR 835, "Occupational Radiation Protection"

29 CFR 1910.94, "Ventilation"

29 CFR 1910, Subpart Q, "Welding, Cutting, and Brazing"

29 CFR 1910.107, "Spray Finishing Using Flammable and Combustible Materials"

29 CFR 1910.108, "Dip Tanks Containing Flammable or Combustible Liquids"

40 CFR 61 (Subpart H), "National Emission Standards for Hazardous Air Pollutants Radionuclides"

40 CFR 170, FIFRA, "Worker Protection Standard"

40 CFR 264 (264.1030, 1050, 1080 et seq.), Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

40 CFR 265 (265.1030, 1050, 1080 et seq.), Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

40 CFR 763, Subpart E, Appendix C, "Asbestos Model Accreditation Plan"

Industrial Ventilation. A Manual of Recommended Practice (American Conference of Governmental Industrial Hygienists, Cincinnati, OH, 23rd edition, 1998).

ANSI Z9.5-1992, "Laboratory Hood Ventilation"

ANSI Z49.1-1994, "Safety in Welding, Cutting and Allied Processes"

NFPA 33 "Standard for Spray Application Using Flammable or Combustible Materials"

NFPA 34," Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids", 1995 Edition

NFPA 45, "Standard on Fire Protection for Laboratories Using Chemicals"

NFPA 54, "National Fuel Gas Code"

NFPA 55, "Standard for Compressed and Liquefied Gases in Portable Cylinders"

NFPA 96, "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations"

UCRL-AR-133354, Rev. 2, *HEPA Filter and In-place Leak Testing Standard* (April 2003).

DOE-HDBK-1081-94 "Primer on Spontaneous Heating and Pyrophoricity"

DOE Order 440.1A, "Worker Protection Management for DOE Federal and Contractor Employees," Attachment 2, "Contractor Requirement Document," Sections 1-11, 13-18 (delete item 18.a), 19 (delete item 19.d.3) and 22.

Department of the Army Pamphlet 40-173, "Working with Mustard Agents"

Department of the Army Pamphlet 40-8, "Working with Nerve Agents"

Semiconductor Equipment and Materials International, "Safety Guidelines for Semiconductor Manufacturing Equipment," Standard SEMI S2-1993 (1993)

11.0 References

1. *ASHRAE Handbook. Fundamentals* (American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Atlanta, GA, latest edition).
2. *Ventilation for Acceptable Indoor Air Quality*, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Standard 62-1989 (or latest edition).

12.0 Resources for More Information

12.1 Contacts

For further information or assistance, contact your area ES&H Team.

12.2 Other Sources

LLNL Indoor Air Quality Guidance and Reference Manual, Martin, J., Hazards Control Department (1994).

LLNL Industrial Hygiene Policy & Implementation Manual No. 79, "Building Discharges to the Environment", Miller, G. (1997)

Appendix A

Terms and Definitions

Air contaminant	A hazardous material or heated gas present in air. Hazardous materials include those that are corrosive, flammable/combustible, irritating, significant nuisances, radioactive, or toxic.
Client	A group soliciting engineering to design and/or install ventilation systems. Clients typically become the users of ventilation systems.
Corrosive	Capable of damaging living tissue or inanimate objects by chemical attack. Corrosive materials include acids, caustics, and sometimes solvents.
Design group	Any on-site or off-site engineering group hired to design ventilation systems.
Dilution (general) ventilation	Mechanically adding large volumes of air to a space where the air is contaminated so the contaminant concentration is reduced to acceptable levels.
Emission	An air contaminant released from a source. Hazardous emissions include those that are flammable/combustible, irritating, significant nuisances, radioactive, or toxic.
Health impact	The appearance of specific symptoms, such as sneezing, headaches, eye irritation, etc., or any condition that causes workers to go to the Health Services Department or to be sent to the Health Services Department for evaluation.
HVAC	Heating, ventilation, and air conditioning. Ventilation systems used to maintain comfortable working conditions as compared to contaminant control ventilation systems.
Modify	To alter a ventilation system in a way that will influence its performance. Modifications can include changing fan speed or static pressure, or adding or removing parts of an existing ventilation system.

NEPA/CEQA	National Environmental Policy Act/California Environmental Quality Act. Regulations promulgated under these acts require a review of the off-site consequences of operations (both NEPA/CEQA) as well as a review of the on-site consequences of operations (CEQA).
Recirculation	Using air for ventilation for more than one pass through a given area. Contaminants picked up during the first pass need to be removed prior to the second pass. Most HVAC systems recirculate air, but many contaminant control systems do not.
Replacement air	Air replacing that removed by a ventilation system.
Resources	Assets needed to complete a task or carry out a mission including funding, space allocations, staffing, communications, and utilities.
Safety analysis	A process of defining the maximum allowable degree of hazard that can be created by operations within a building mandated by DOE. See Document 2.2, "Managing ES&H for LLNL Work," in the *ES&H Manual* and its associated documents for additional information. DOE requires a review of the on- and off-site consequences of planned operations.
Significant nuisance	A situation that is not a hazard to health, but which is so distressing that it can cause people to stop work (such as nauseating or strong odors).
Ventilation system	A system which moves air in a controlled manner. It usually, but not always, consists of the following: • Hood or hoods to collect hazardous air contaminants or heated gasses. • Ductwork to convey the trapped material in a controlled manner. • A fan/air mover to propel the trapped material and air in a purposeful manner. • An exhaust opening or openings. Some ventilation systems may include air-cleaning equipment, such as HEPA filters, to prevent noxious materials from being discharged into the general environment.